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WATER RESOURCES REVIEW for

NOVEMBER

1972

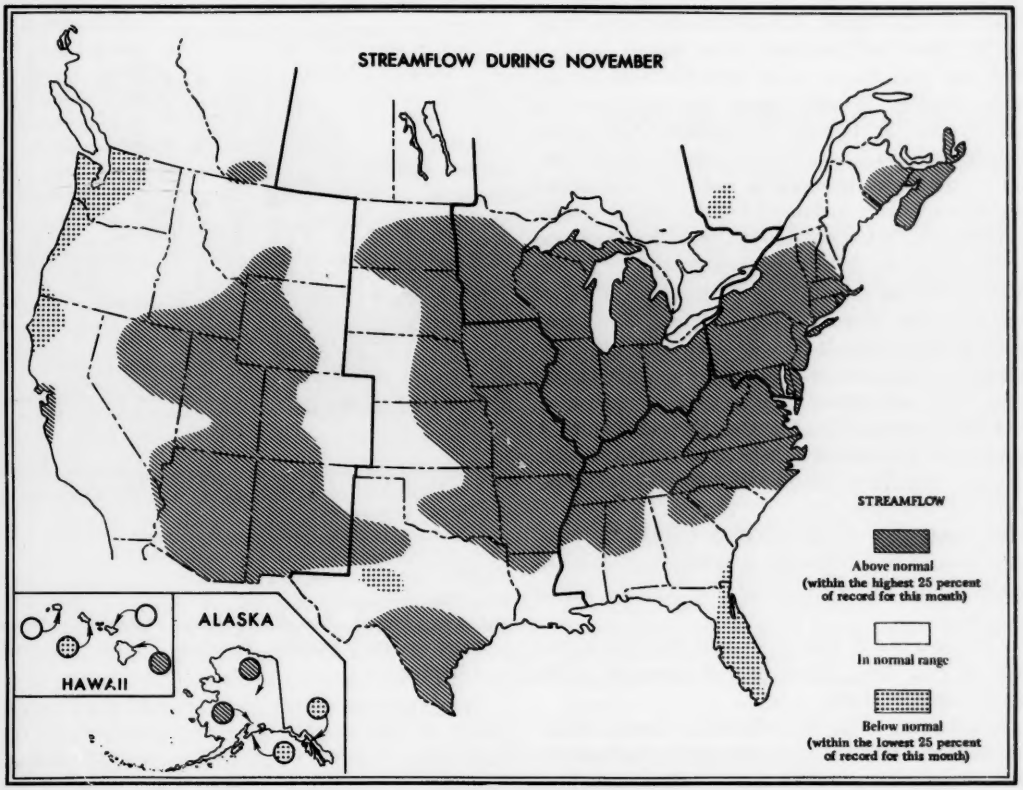
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CANADA
DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES BRANCH

STREAMFLOW AND GROUND—WATER CONDITIONS

Streamflow increased in most of the United States; but decreased in much of southern Canada, as well as in Alaska, and in a broad band from Montana through Arizona. Flooding occurred in California, accompanied by mud slides, and in Arkansas and Missouri. Lakeshore flooding, resulting from strong onshore winds and intense rains, occurred along portions of Lakes Erie and Huron in Ohio and Michigan.

Above-normal streamflow characterized the water-supply picture over most of eastern and central United States, and over a large area of the West, centered on southeastern Utah. Flows also were above normal in smaller areas in Alaska, and in the Atlantic Provinces of Canada. New maximum monthly or daily mean discharges for November were observed at index stations in Arizona, New Mexico, Indiana, Iowa, Missouri, Ohio, Virginia, and West Virginia.



CONTENTS OF THIS ISSUE: Northeast, Southeast, Western Great Lakes region, Midcontinent, West; Usable contents of selected reservoirs near end of November 1972; Flow of large rivers during November 1972; Alaska; Ground-water outflow from Chino basin, upper Santa Ana Valley, southern California.

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NORTHEAST

[Atlantic Provinces and Quebec; Delaware, Maryland, New York, New Jersey, Pennsylvania, and the New England States]

STREAMFLOW DECREASED IN PARTS OF NEW BRUNSWICK, QUEBEC, AND MAINE, BUT INCREASED ELSEWHERE IN THE REGION. FLOWS WERE ABOVE NORMAL IN A LARGE AREA IN THE CENTRAL AND SOUTHERN SECTIONS, AND IN PART OF THE NORTHEASTERN SECTION, INCLUDING ALL OF NOVA SCOTIA AND SOME COASTAL AREAS OF NEW BRUNSWICK.

November monthly mean discharges at index streamflow stations from southern Maine, in the north, to Maryland-Delaware in the south, were generally several times greater than those of October. The largest increases occurred in the Susquehanna River basin where November means at Conklin, N.Y., and at Harrisburg, Pa., were roughly 13 and 8 times, respectively, the means of October.

In New Jersey, monthly mean discharge of Delaware River at Trenton (drainage area, 6,780 square miles), was 24,651 cfs, the highest November mean since 1933, fourth highest for the month since records began in 1913, and more than 6 times the mean flow observed during October. Monthly mean flow of Great Egg Harbor River at Folsom, in southern New Jersey (drainage area, 56.3 square miles), was 216 cfs, 281 percent of the November median, and above the normal range where it has been during 11 of the past 15 months.

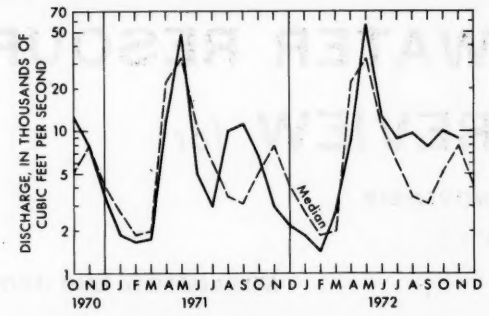
Flows at all index stations in Connecticut increased sharply during the month and were about 3 to 5 times those of October. Monthly mean discharge of Mount Hope River near Warrenville (drainage area, 28.6 square miles), increased from 25.5 cfs in October to 126 cfs in November, only 5 cfs less than the maximum for the month, in 32 years of record.

At Washington, D.C., the monthly mean flow of Potomac River increased to 19,400 cfs, almost double the mean observed in October, and 466 percent of the median for November.

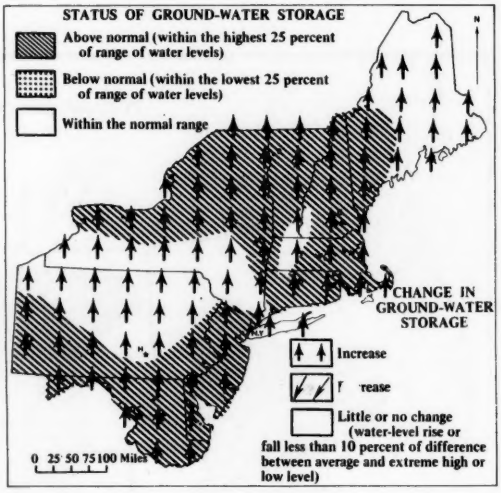
The continuing above-normal streamflow in Nova Scotia resulted in a 16-percent increase in the combined storage in the six reservoirs of the Province during November.

In northern Maine, flow of St. John River below Fish River at Fort Kent, decreased and remained in the normal range (see graph).

Ground-water levels rose sharply in much of the Northeast as a result of unusually good conditions for ground-water recharge: (1) above-normal precipitation, (2) minimal evapotranspiration (low or moderately low air temperatures), and (3) generally unfrozen land surface. Levels near monthend were the highest for November in many years in several areas, including eastern and central Massachusetts, southeastern New Hampshire, and parts of Maryland and New Jersey.



Monthly mean discharge of St. John River below Fish River at Fort Kent, Maine (Drainage area, 5,690 square miles.)


STATUS OF GROUND-WATER STORAGE
Above normal (within the highest 25 percent of range of water levels)
Below normal (within the lowest 25 percent of range of water levels)
Within the normal range
CHANGE IN GROUND-WATER STORAGE
Increase
Little or no change (water-level rise or fall less than 10 percent of difference between average and extreme high or low level)
0 25 50 75 100 Miles

Map above shows ground-water storage near end of November and change in ground-water storage from end of October to end of November.

SOUTHEAST

[Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia]

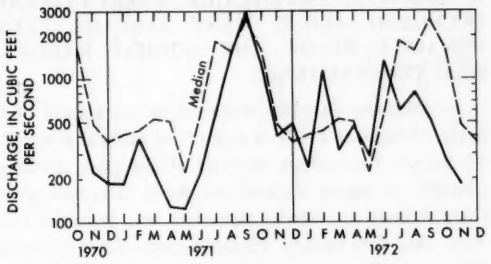
STREAMFLOW INCREASED SEASONALLY OVER MOST OF THE REGION WITH THE EXCEPTIONS OF VIRGINIA AND FLORIDA. ABOVE-NORMAL FLOWS CONTINUED OVER THE NORTHERN SECTION OF THE REGION AND EXPANDED INTO

SOUTH CAROLINA AND ALABAMA. BELOW-NORMAL FLOWS CONTINUED IN MOST OF THE FLORIDA PENINSULA AND ADJACENT COASTAL AREA OF GEORGIA.

In West Virginia, new November monthly maximums were reported on the Greenbrier River at Alderson (drainage area, 1,357 square miles), and the Potomac River at Paw Paw (drainage area, 3,109 square miles). These two drainage basins cover the eastern part of the State. Monthly mean flow of Greenbrier River was 4,991 cfs, over 9½ times the monthly median. Records have been kept at this station since August 1895. The monthly mean flow on the Potomac of 6,413 cfs exceeded the previous November high by over 2,000 cfs. Monthly mean discharge of the Kanawha River (see table of large rivers) was the fourth highest of record for November since records began in April 1877.

In adjacent Virginia, three of the four index stations recorded new maximum monthly discharges for November. This was the second consecutive record monthly mean for Nottoway River near Stony Creek (drainage area, 579 square miles) and Slate River near Arvonia (drainage area, 226 square miles) in south-central Virginia.

In Florida, streamflow for November increased to normal ranges in the northwest and a small portion of the southeast. Shoal River, near Crestview in the western panhandle, had been below normal since May. In most of the peninsular area, streamflow continued to be below normal. Peace River in south-central Florida continued below normal for the fifth consecutive month (see graph). The flow at Silver Springs, in north-central



Monthly mean discharge of Peace River at Arcadia, Fla. (Drainage area, 1,370 square miles.)

Florida, decreased to 700 cfs; 80 percent of normal. Flow southward through the Tamiami Canal outlets, 40-mile bend to Monroe, decreased to 48 cfs; 18 percent of normal. The flow of Miami Canal at Miami increased to 245 cfs; 58 percent of normal.

Ground-water levels generally rose as a result of above-normal precipitation in November in the region, but fell in most wells in Florida. Monthend levels followed about the same pattern as the monthly changes except for a few special cases. In West Virginia and Kentucky, levels rose and reached record highs for November in southeastern West Virginia and in a key well near Mayfield, Graves County, Ky. Records extend back to 1951 for the latter well. Levels were above average throughout both States. Monthend levels were well above the long-term average in North Carolina even though levels fell for the fourth consecutive month in the mountains and Piedmont areas and showed their first rise in four months in the eastern Coastal Plain. In Georgia, levels rose during the month but were generally a foot or two below the 1971 levels; in heavily pumped areas such as East Point (Atlanta area) and Savannah, a new low since 1955 and a new monthly low were established in the two areas, respectively. Similarly, at Memphis, Tenn., a new monthly low was reached despite a rise in water level in November. In Florida, levels declined in most areas in the northern and central parts of the State. Monthend levels ranged from 2.5 feet below average at Orlando to 18.5 feet below average in west-central Polk County (near Hillsborough County). Levels declined to a new record low at Pensacola (westernmost panhandle), and to a new monthly low near Tampa for the third consecutive month. Scattered rises in levels occurred in Broward, Dade, and Palm Beach Counties in southeast Florida but monthend levels were below normal.

WESTERN GREAT LAKES REGION

[Ontario; Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin]

STREAMFLOW INCREASED THROUGHOUT THE REGION EXCEPT IN SMALL AREAS OF EASTERN ONTARIO AND NORTHEASTERN WISCONSIN, AND WAS ABOVE THE NORMAL RANGE AT ALL OF THE INDEX STATIONS IN THE UNITED STATES. RECORD-BREAKING MONTHLY MEAN FLOWS OCCURRED IN PARTS OF OHIO AND INDIANA. SEVERE LAKESHORE FLOODING ALONG PORTIONS OF LAKES ERIE AND HURON IN OHIO AND MICHIGAN WAS CAUSED BY STRONG ON-SHORE WINDS AND HEAVY RAINS.

Gale-velocity winds from the northeast, accompanied by large amounts of rain, caused severe flood damage November 14–15 along the southern portion of Lake Erie shore from the Vermilion-Huron area westward to Toledo, Ohio and Monroe, Michigan, and also along the western shore of Lake Huron in Michigan. The maximum water-surface elevation of Lake Erie at Toledo, Ohio, was reported by NOAA-NOS-Lake Survey to have been about 577 feet above mean sea level during the storm (approximately 2 feet higher than the previously-recorded maximum, and 8.4 feet above low-water datum).

Streamflow throughout Ohio was above the normal range for the third consecutive month. Monthly mean discharge of Scioto River at Chillicothe (drainage area, 3,849 square miles), was 11,616 cfs, highest for November in 51 years of record, 15 times the monthly median, and in the above-normal range for the fifth consecutive month.

In northeastern Indiana, monthly mean discharge of Mississinewa River at Marion (drainage area, 682 square miles), was 2,497 cfs, highest for November in 49 years of record, roughly 4 times the mean flow during Octber, and above the normal range for the 3d consecutive month. Rainfall for the month at Indianapolis for November was the highest during this century.

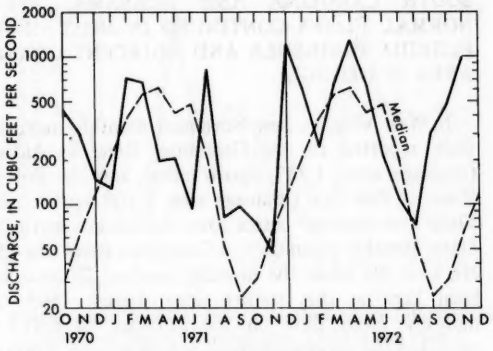
In east-central Minnesota, the monthly mean discharge of Crow River at Rockford (drainage area, 2,520 square miles), was 1,159 cfs, 20 times the November median, and above the normal range for the 26th consecutive month. In southern Minnesota, monthly mean discharge of Minnesota River near Jordan (drainage area, 16,200 square miles), was 3,890 cfs, 466 percent of the November median, more than twice the October monthly mean, and above the normal range.

Streamflow has been in the above-normal range throughout Wisconsin for four consecutive months. Monthly mean flows at the index stations varied from 147 to 451 percent of the Novemnber medians.

In Michigan, streamflow has been above the normal range for four consecutive months in the Upper Peninsula and for three of the past four months in the Lower Peninsula. Monthly mean discharge of Red Cedar River at East Lansing (drainage area, 355 square miles), was 377 cfs, second highest November flow since records began in 1930, and 500 percent of the November median.

In central Illinois, flow of Sangamon River at Monticello, augmented by high carryover flow from October and by mid-November rains, increased seasonally to 981 cfs, more than twice the mean flow during October, and 1,510 percent of the November median (see graph).

Ground-water levels rose in most of the shallow aquifers of the region (with rises averaging two feet in Indiana); however, in Minnesota, levels in water-table wells declined but were above average levels for November. Water levels also declined in the deep artesian aquifers in the Milwaukee area because of pumping. Monthend levels were generally above average in the region; levels ranged from new monthly highs for November in some local areas in Michigan to well above average in nearly all other parts of the State. Water levels were at a record high stage in Ohio, well above average in Indiana, and above normal in Wisconsin. The level in the key well at Fort Ripley, Morrison County, in central Minnesota, was the highest for November in 21 years of record. Levels in wells tapping artesian aquifers underlying the Twin Cities area continued to rise but were below average for November.



Monthly mean discharge of Sangamon River at Monticello, Ill. (Drainage area, 550 square miles.)

MIDCONTINENT

[Manitoba and Saskatchewan; Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas]

STREAMFLOW INCREASED AND WAS ABOVE THE NORMAL RANGE THROUGHOUT MOST OF THE REGION. THE GREATEST INCREASES WERE IN ARKANSAS AND MISSOURI WHERE FLOODING OCCURRED ALONG MANY STREAMS. FLOWS REMAINED BELOW THE NORMAL RANGE IN WEST-CENTRAL TEXAS.

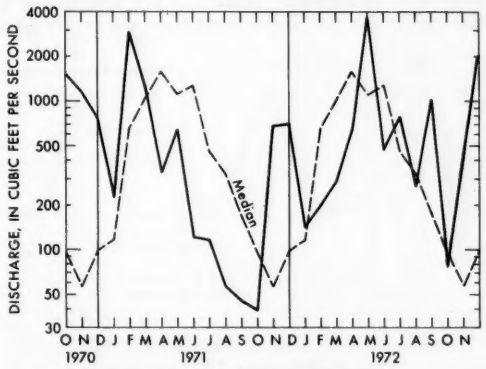
In Arkansas, flooding occurred in most areas of the State, November 1–13 as a result of rains of as much as 10 inches. Recurrence intervals of the peak discharges observed at gaging stations are about 20 years or less. Crop damage in eastern Arkansas was reported to be more than $90 million. Monthly mean flows of Buffalo River near St. Joe, in the north, and Saline River near Rye, in the south, were more than 40 times those of October, and roughly 13 and 20 times, respectively, the November medians for those two sites.

In southwestern Missouri, extensive flooding resulted from rains of 8 to 12 inches during the period November 1–3. Monthly total precipitation was greatest of record for November at some observation points. Peak stages and discharges observed at several stream-gaging stations are listed in the table below. Recurrence intervals of the peak discharges are 15 years.

Minor flooding was common in the southeastern and central areas of the State, November 1–5 and 13–17.

Station	Drainage area (square miles)	Maximum during present flood		
		Date	Stage (feet)	Discharge (cfs)
Turnback Creek above Greenfield (6–9184.6).	252	Nov. 1	24.45	23,000
Pomme de Terre River near Polk (6–9210.7).	276	1	21.88	21,000
Spring River at Larussell (7–1857).	306	1	17.98	24,000
Spring River at Carthage (7–1857.65).	425	1	17.2	25,000
Center Creek near Carterville (7–1864).	232	1	15.7	20,000

Monthly mean discharge of Gasconade River at Jerome, in central Missouri (drainage area, 2,840 square miles), increased from 798 cfs in October to 8,158 cfs in November, and the daily mean discharge on the 3d was 31,000 cfs, highest for a day in November in the 52 years of record. In the northwest, monthly mean discharge of Grand River near Gallatin increased sharply and was nearly 32 times the November median (see graph).



Monthly mean discharge of Grand River near Gallatin, Mo. (Drainage area, 2,250 square miles.)

In Texas, streamflow was above the normal range in all south-central basins, as well as in the Sulphur River basin in the east, and the upper Colorado River and Brazos River basins in the west. The only area of below-normal streamflow in the region during November was west-central Texas. Flow of Comal Springs at New Braunfels was 345 cfs near the end of the month.

In northeastern Nebraska, monthly mean discharge of Elkhorn River at Waterloo (drainage area, 6,900 square miles), was in the above-normal range for the fourth consecutive month. Excessive snowfall for November was reported over the entire State, with up to 25 inches in the north-central area.

South-central South Dakota also received 25 inches of snow during the month. Streamflow in the eastern part of that State increased appreciably and continued above the normal range.

Streamflow in south-central Oklahoma increased sharply and monthly mean discharge of Washita River near Durwood was above the normal range for the first month since December 1971. Flow at this index station was below the normal range during seven of the last eight months of the 1972 water year.

In eastern Iowa, monthly mean discharge of Cedar River at Cedar Rapids, 9,381 cfs, and Des Moines River at Keosauqua, 13,900 cfs, were highest for November in 70 and 62 years of record, respectively. Similarly, monthly mean flows of Winnebago River at Mason City, in north-central Iowa, and Nishnabotna River above Hamburg, in the southwest, were highest for November in 40 and 45 years of record, respectively. Also, flow of Mississippi River at Keokuk, Iowa, was second highest for November in 93 years of record.

Streamflow decreased slightly in North Dakota but remained above the normal range as a result of carryover runoff from October rain and/or snowmelt.

The level of Lake Winnipeg at Gimli, Manitoba, averaged 714.19 feet above mean sea level, 0.88 foot above the long-term mean for the month.

Ground-water levels rose seasonally in the region. Monthend levels were above average in the northern part of the region, except for wells in Nebraska and Kansas which are in heavily pumped areas; and a new November high was recorded in a well in the glacial drift in east-central Iowa.

In the rice-growing area of east-central Arkansas, the water level in the shallow aquifer (Quaternary deposits) rose slightly and was in the same range of November values that it has been since 1964; the water level in the deep aquifer (Sparta Sand) rose seasonally, but was at a new low for November. In the industrial aquifer of central and south Arkansas (the Sparta Sand), the level in the key well at Pine Bluff rose but was a new November low that was 3 feet lower than a year ago; the level in the Sparta Sand at El Dorado, south-central Arkansas, rose 3 feet; it was a little above the November average, 11 feet higher than a year ago, and 23 feet higher than November 1966.

In Texas, water levels were above average in the Edwards Limestone at Austin and San Antonio but

below average in the Evangeline aquifer at Houston and in the bolson deposits at El Paso. Water levels rose at San Antonio, Houston, and El Paso, but declined at Austin. New November lows were recorded at Houston and El Paso. In Louisiana, water levels in the terrace aquifer in the northwest dropped slightly; however, water levels in most of the other aquifers reached their seasonal lows and were rising by monthend.

WEST

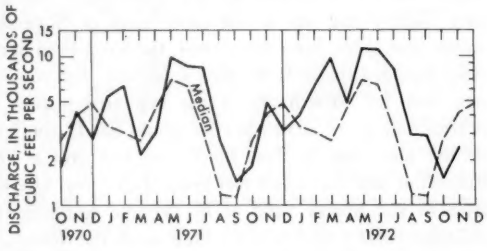
[Alberta and British Columbia; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming]

STREAMFLOW GENERALLY DECREASED IN A NORTH-SOUTH BAND FROM SOUTHERN ALBERTA TO SOUTHERN ARIZONA, AND GENERALLY INCREASED IN THE COASTAL STATES AND IN VANCOUVER ISLAND, IN NORTHERN NEVADA, AND IN SOME BASINS OF SOUTHERN WYOMING, EASTERN COLORADO, AND NORTHERN NEW MEXICO. A LARGE AREA OF ABOVE-NORMAL STREAMFLOW PERSISTED IN THE CENTRAL AND SOUTH-CENTRAL SECTIONS, AND SMALL AREAS OF BELOW-NORMAL FLOW CONTINUED IN COASTAL BASINS OF NORTHERN CALIFORNIA, AND WESTERN OREGON AND WASHINGTON. LOCAL FLOODING AND MUD SLIDES OCCURRED IN CENTRAL AND SOUTHERN COASTAL AREAS OF CALIFORNIA.

On Vancouver Island, monthly mean flow of Sproat River near Alberni, after declining steadily from 3,290 cfs in March 1972 to 371 cfs in October 1972, increased sharply to 1,390 cfs in November, but was only 81 percent of median for the month.

In southern British Columbia and Alberta, streamflow decreased for the fifth consecutive month.

Streamflow increased seasonally at all index stations in Washington, but monthly mean discharge of Skyomish River near Gold Bar was only 2,454 cfs, 60 percent of the November median (see graph) and below the normal range for the second consecutive month.



Monthly mean discharge of Skykomish River near Gold Bar, Wash. (Drainage area, 535 square miles.)

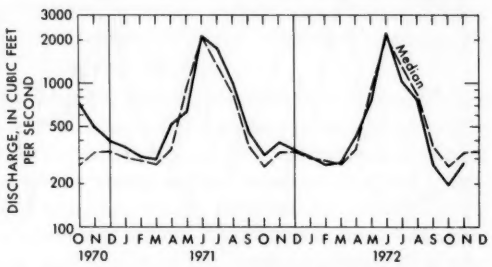
In western Oregon, flow of Wilson River near Tillamook remained in the below-normal range, and flow of Willamette River at Salem increased but was below the normal range for November. Flow of Columbia River at The Dalles remained in the above-normal range for the seventh consecutive month.

In southern Montana, flows of Yellowstone River at Corwin Springs and at Billings decreased but remained above the normal range as a result of heavy November precipitation.

In California, local flooding and mud slides occurred along much of the Coast Range and were especially severe in the Big Sur area of the central coast. Minor flooding and mud slides occurred in the Los Angeles area as a result of two storms, each producing rains of 1 to 3 inches. In the extreme northern coastal area, monthly mean discharge of Smith River near Crescent City increased seasonally but was only 39 percent of the November median and below the normal range for the fourth consecutive month.

In southeastern Idaho, monthly mean discharge of Snake River near Heise (drainage area, 5,732 square miles) was 4,091 cfs and in the above-normal range where it has remained during 13 of the past 14 months. Flow of Snake River at Weiser, below the irrigated tracts of southern Idaho, was the second highest for November in 63 years of record. In west-central Idaho, monthly mean discharge of Salmon River at White Bird decreased, and was in the normal range for the first month since May 1972. Flows of Cour d'Alene River and other streams draining low elevations were below the normal range.

In central Colorado, flow of Arkansas River at Canyon City increased seasonally but remained below the median for the fifth consecutive month (see graph).



Monthly mean discharge of Arkansas River at Canon City, Colo. (Drainage area, 3,117 square miles.)

In western Colorado, monthly mean discharge of Animas River at Durango and Roaring Fork at Glenwood Springs, draining areas west of the Continental Divide, continued in the above-normal range.

Monthly mean discharge was above the normal range at all index stations in Arizona. The November mean discharge of Gila River at head of Safford Valley, near Solomon (drainage area, 7,806 square miles), was 800 cfs, highest for the month since 1914. High carryover flow from October contributed to a monthly mean discharge on Little Colorado River near Cameron, in north-

Provisional data; subject to revisio .

USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF NOVEMBER 1972

[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	End of Oct. 1972	End of Nov. 1972	End of Nov. 1971	Average for end of Nov.	Normal maximum
	Percent of normal maximum				
NORTHEAST REGION					
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	36	52	32	37	223,400 (a)
QUEBEC					
Gouin (P)	63	66	54	70	6,487,000 ac-ft
Allard (P)	86	94	70	56	280,600 ac-ft
MAINE					
Seven reservoir systems (MP)	59	62	36	54	179,300 mcf
NEW HAMPSHIRE					
Lake Winnipesaukee (PR)	64	81	56	54	7,200 mcf
Lake Francis (FPR)	76	82	63	78	4,326 mcf
First Connecticut Lake (P)	80	86	60	77	3,330 mcf
VERMONT					
Somerset (P)	61	72	65	69	2,500 mcf
Harriman (P)	60	79	50	64	5,060 mcf
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	66	76	76	72	3,394 mcf
NEW YORK					
Great Sacandaga Lake (FPR)	52	72	59	54	34,270 mcf
Indian Lake (FMP)	81	85	43	57	4,500 mcf
New York City reservoir system (MW)	68	81	64	.....	547,500 mg
NEW JERSEY					
Wanaque (M)	57	89	91	66	27,730 mg
PENNSYLVANIA					
Wallenpaupack (P)	59	75	46	48	6,875 mcf
Pymatuning (FMR)	91	91	75	76	8,191 mcf
MARYLAND					
Baltimore municipal system (M)	98	100	102	81	85,340 mg
SOUTHEAST REGION					
NORTH CAROLINA					
Bridgewater (Lake James) (P)	78	77	88	74	12,580 mcf
High Rock Lake (P)	50	65	69	55	10,230 mcf
Narrows (Badin Lake) (P)	93	91	89	92	5,616 mcf
SOUTH CAROLINA					
Lake Murray (P)	80	78	80	54	70,300 mcf
Lakes Marion and Moultrie (P)	86	77	81	58	81,100 mcf
SOUTH CAROLINA––GEORGIA					
Clark Hill (FP)	55	52	67	46	75,360 mcf
GEORGIA					
Burton (PR)	69	72	66	52	104,000 ac-ft
Lake Sidney Lanier (FMPR)	40	41	50	46	1,686,000 ac-ft
Sinclair (MPR)	61	58	71	68	214,000 ac-ft
ALABAMA					
Lake Martin (P)	59	63	72	56	1,373,000 ac-ft
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	47	43	38	25	1,166,000 cfsd
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	63	54	51	29	1,452,000 cfsd
Douglas Lake (FPR)	37	23	21	14	715,800 cfsd
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	54	50	50	39	523,700 cfsd
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	64	58	47	36	751,400 cfsd
WESTERN GREAT LAKES REGION					
WISCONSIN					
Chippewa and Flambeau (PR)	96	94	92	73	15,900 mcf
Wisconsin River (21 reservoirs) (PR)	93	88	83	63	17,400 mcf
MINNESOTA					
Mississippi River headwater system (FMR)	32	29	32	27	1,640,000 ac-ft
MIDCONTINENT REGION					
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	96	95	93	.....	22,640,000 ac-ft
NEBRASKA					
Lake McConaughy (IP)	75	78	90	67	1,948,000 ac-ft
OKLAHOMA					
Keystone (FPR)	79	95	93	93	661,000 ac-ft
Lake O' The Cherokees (FPR)	92	102	94	78	1,492,000 ac-ft
Tenkiller Ferry (FPR)	80	106	85	93	628,200 ac-ft
Lake Altus (FIMR)	9	9	16	47	134,500 ac-ft
Eufaula (FPR)	70	106	93	78	2,378,000 ac-ft
OKLAHOMA––TEXAS					
Lake Texoma (FMPRW)	75	99	90	90	2,722,000 ac-ft
TEXAS					
Possum Kingdom (IMPRW)	95	95	95	79	724,500 ac-ft
Buchanan (IMPW)	78	79	95	76	955,200 ac-ft
Bridgeport (IMW)	51	57	57	59	270,900 ac-ft
Eagle Mountain (IMW)	90	91	92	86	182,700 ac-ft
Medina Lake (I)	98	96	100	46	254,000 ac-ft
Lake Travis (FIMPRW)	87	91	102	76	1,144,000 ac-ft
Lake Kemp (IMW)	45	42	27	53	461,800 ac-ft
THE WEST					
ALBERTA					
Spray (P)	81	75	69	67	210,000 ac-ft
Lake Minnewanka (P)	89	90	70	75	199,700 ac-ft
St. Mary (I)	66	69	73	60	320,800 ac-ft
WASHINGTON					
Franklin D. Roosevelt Lake (IP)	98	96	95	96	5,232,000 ac-ft
Lake Chelan (PR)	78	65	57	64	676,100 ac-ft
IDAHO––WYOMING					
Upper Snake River (7 reservoirs) (IMP)	73	73	75	56	4,282,000 ac-ft
WYOMING					
Pathfinder, Seminoe, Alcova, Kortes, and Glendo Reservoirs (I)	60	62	69	33	3,016,000 ac-ft
Buffalo Bill (IP)	82	80	77	72	421,300 ac-ft
Boysen (FIP)	85	80	89	78	802,000 ac-ft
Keyhole (F)	85	84	78	32	199,900 ac-ft
COLORADO					
John Martin (FIR)	0	1	1	15	364,400 ac-ft
Colorado–Big Thompson project (I)	71	72	75	53	722,600 ac-ft
Taylor Park (IR)	33	33	59	53	106,000 ac-ft
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Navajo, and Blue Mesa Reservoirs (IFPR)	57	57	57	.....	31,276,500 ac-ft
UTAH––IDAHO					
Bear Lake (IPR)	85	83	82	55	1,421,000 ac-ft
CALIFORNIA					
Hetch Hetchy (MP)	49	39	45	39	360,400 ac-ft
Lake Almanor (P)	76	72	70	42	1,036,000 ac-ft
Shasta Lake (FIPR)	75	75	73	64	4,377,000 ac-ft
Millerton Lake (FI)	36	47	35	37	503,200 ac-ft
Pine Flat (FI)	24	28	40	37	1,014,000 ac-ft
Isabella (FIR)	9	9	22	19	551,800 ac-ft
Folsom (FIP)	61	60	57	48	1,000,000 ac-ft
Lake Berryessa (FIMW)	71	73	84	74	1,600,000 ac-ft
Clair Engle Lake (Lewiston) (P)	76	75	79	71	2,438,000 ac-ft
CALIFORNIA––NEVADA					
Lake Tahoe (IPR)	61	59	69	46	744,600 ac-ft
NEVADA					
Rye Patch (I)	80	79	87	40	179,100 ac-ft
ARIZONA––NEVADA					
Lake Mead and Lake Mohave (FIMP)	69	70	67	66	27,970,000 ac-ft
ARIZONA					
San Carlos (IP)	31	37	11	12	948,600 ac-ft
Salt and Verde River system (IMPR)	55	62	42	32	2,073,000 ac-ft
NEW MEXICO					
Conchas (FIR)	60	61	43	77	352,600 ac-ft
Elephant Butte and Caballo (FIPR)	10	13	5	25	2,539,000 ac-ft

[a] Thousands of kilowatt-hours.

Provisional data; subject to revision

FLOW OF LARGE RIVERS DURING NOVEMBER 1972

WRD station number	Stream and place of determination	Drainage area (square miles)	Mean annual discharge through September 1970	November 1972					
				Monthly discharge (cfs)	Percent of median monthly discharge[1]	Change in discharge from previous month (percent)	Discharge near end of month		
							(cfs)	(mgd)	Date
1–0140	St. John River below Fish River at Fort Kent, Maine.	5,690	9,397	8,961	127	−11	6,000	3,880	30
1–3580	Hudson River at Green Island, N.Y.	8,090	12,520	25,500	295	+255	.....	.....	...
1–4635	Delaware River at Trenton, N.J	6,780	11,360	24,651	273	+525	29,900	19,300	28
1–5705	Susquehanna River at Harrisburg, Pa.	24,100	33,670	50,390	240	+665	50,900	32,900	30
1–6465	Potomac River near Washington, D.C.	11,560	[2]10,640	19,400	466	+75	25,000	16,000	30
2–1055	Cape Fear River at William O. Huske Lock near Tarheel, N.C.	4,810	4,847	8,490	365	+210	10,800	6,980	30
2–1310	Pee Dee River at Peedee, S.C	8,830	9,098	7,230	161	+54	10,600	6,850	28
2–2260	Altamaha River at Doctortown, Ga.	13,600	13,380	3,383	72	+34	4,960	3,200	26
2–3205	Suwannee River at Branford, Fla	7,740	6,775	2,530	59	-13	2,560	1,650	30
2–3580	Apalachicola River at Chattahoochee, Fla.	17,200	21,690	10,500	95	+8	12,000	7,760	29
2–4670	Tombigbee River at Demopolis lock and dam near Coatopa, Ala.	15,400	21,700	8,192	141	+208	15,800	10,200	27
2–4895	Pearl River near Bogalusa, La	6,630	8,533	3,049	179	+46	2,800	1,800	30
3–0495	Allegheny River at Natrona, Pa	11,410	[2]18,700	28,460	264	+188	26,700	17,300	27
3–0850	Monongahela River at Braddock, Pa.	7,337	[2]11,950	21,360	329	+218	32,200	20,800	27
3–1930	Kanawha River at Kanawha Falls, W.Va.	8,367	12,370	22,180	336	+117	14,800	9,570	26
3–2345	Scioto River at Higby, Ohio	5,131	4,337	15,400	1,361	+328	7,780	5,030	27
3–2945	Ohio River at Louisville, Ky[3]	91,170	110,600	186,100	420	+264	149,100	96,400	27
3–3775	Wabash River at Mount Carmel, Ill.	28,600	26,310	56,300	749	+150	54,200	35,000	30
3–4690	French Broad River below Douglas Dam, Tenn.	4,543	[2]6,528	6,800	194	-2	.....	.....	...
4–0845	Fox River at Rapide Croche Dam, near Wrightstown, Wis.[3]	6,150	4,142	7,600	268	+4	.....	.....	...
4–2643.31	St. Lawrence River at Cornwall, Ontario–near Massena, N.Y.[4]	299,000	239,100	293,300	129	-3	295,000	191,000	30
5–0825	Red River of the North at Grand Forks N. Dak.	30,100	2,439	1,368	126	-22	.....	.....	...
5–3300	Minnesota River near Jordan, Minn ..	16,200	3,306	3,890	466	+124	2,700	1,740	29
5–3310	Mississippi River at St. Paul, Minn ...	36,800	[2]10,230	16,290	288	+50	11,100	7,170	28
5–3655	Chippewa River at Chippewa Falls, Wis.	5,600	5,062	9,265	262	+9	.....	.....	...
5–4070	Wisconsin River at Muscoda, Wis	10,300	8,457	13,923	234	-28	10,800	6,980	25
5–4465	Rock River near Joslin, Ill	9,520	5,288	11,170	391	-17	9,020	5,830	30
5–4745	Mississippi River at Keokuk, Iowa ...	119,000	61,210	113,000	311	+5	.....	.....	...
5–4905	Des Moines River at Keosauqua, Iowa.	14,038	5,220	13,900	888	+137	12,600	8,140	28
6–2145	Yellowstone River at Billings, Mont.	11,795	6,754	4,812	134	-25	.....	.....	...
6–9345	Missouri River at Hermann, Mo	523,200	78,480	134,000	307	+93	115,000	74,300	27
7–2890	Mississippi River near Vicksburg, Miss.[5]	1,144,500	552,700	824,200	283	+99	970,000	627,000	30
9–3150	Green River at Green River, Utah ...	40,600	6,369	3,769	149	+21	.....	.....	...
9–4025	Colorado River near Grand Canyon, Ariz.	137,800	.....	11,840	.....	-14	.....	.....	...
11–4255	Sacramento River at Verona, Calif ...	21,257	18,370	20,890	181	+48	23,300	15,100	27
13–2690	Snake River at Weiser, Idaho	69,200	17,670	21,840	154	0	22,000	14,200	28
13–3170	Salmon River at White Bird, Idaho ..	13,550	11,060	5,044	98	-8	5,250	3,390	28
13–3425	Clearwater River at Spalding, Idaho ..	9,570	15,320	5,130	95	+65	7,200	4,650	28
14–1057	Columbia River at The Dalles, Oreg.[6]	237,000	194,000	125,500	118	+7	.....	.....	...
14–1910	Willamette River at Salem, Oreg	7,280	23,370	16,000	58	+52	11,000	7,110	30
15–5155	Tanana River at Nenana, Alaska	27,500	24,040	6,590	79	-48	6,200	4,010	30
	Fraser River at Hope, British Columbia.	78,300	95,300	53,800	90	-22	41,100	26,600	28

[1] Reference period 1931–60 or 1941–70.
[2] Adjusted.
[3] Record furnished by Corps of Engineers.
[4] Record furnished by Buffalo district, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.
[5] Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.
[6] Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

West—Continued from page 6.
central Arizona, that was nearly 50 times the November median. The mean flow during October at that index station was 14,400 percent of the median for the month.

Ground-water levels generally declined in Washington, Idaho, Montana, northern and southern Utah, southern California, and in some wells in Arizona. Water levels rose in most wells in Nevada and in New Mexico. Monthend levels were generally below average in western Washington but above average in eastern Washington. In sand and gravel aquifers in the Boise Valley area, seasonal declines took place but levels remained above average. Water levels in the Snake Plain aquifer were above average near Atomic City but below average near Rupert, in Minidoka County, southern Idaho. Water levels were higher in November than in October in the central part of Utah, and a new high was established for November at Blanding, near the southeast corner of the State. Water levels were above average in Nevada for November except in Truckee Meadows and Las Vegas Valley, where new monthly lows were established because of pumping. In Arizona, changes in water levels in observation wells ranged from -3.94 to +1.81 feet in November with new monthly lows being measured at the Sahuarita, Elfrida, and Avra Valley wells. Monthend levels in New Mexico observation wells remained below average but generally higher than last month and last year. The well near Roswell, representative of wells tapping the principal aquifer, recorded a rise of 4 feet from October (San Andres Limestone); however, the well in the shallow aquifer in the southern part of the Roswell basin set an alltime low record. Water level in the key well at Deming, in the southwest corner of New Mexico, rose nearly 2 feet in November.

ALASKA

Streamflow decreased seasonally throughout the State and remained below the normal range on Sheep Creek near Juneau and Tanana River at Nenana, in the southeastern and central sections, respectively. In the east-central and south-central parts of the State, monthly mean flows of Chena River at Fairbanks (drainage area, 1,980 square miles), 942 cfs, and Little Susitna River near Palmer (drainage area, 61.9 square miles), 95.2 cfs, were highest for November in 23 and 24 years of record, respectively, because of mild temperatures throughout the month.

Ground-water levels had a seasonal rise in the Kenai and Anchorage areas.

WATER RESOURCES REVIEW **NOVEMBER 1972**

Cover map shows generalized pattern of streamflow for November based on 22 index stream-gaging stations in Canada and 130 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations which are located near the points shown by the arrows.

Streamflow for November 1972 is compared with flow for November in the 30-year reference period 1931–60 or 1941–70. Streamflow is considered to be *below normal* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow for November is considered to be *above normal* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being within the *normal range.* In the Water Resources Review *normal flow* is defined as the median of the 30 flows of November during the reference period. The normal (median) has been obtained by ranking those 30 flows in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the normal (median). The normal is an average (but not an arithmetic average) or middle value; half of the time you would expect the November flows to be below the median and half of the time to be above the median. Shorter reference periods are used for the Alaska index stations because of the limited records available.

Statements about *ground-water levels* refer to conditions near the end of November. Water level in each key observation well is compared with average level for the end of November determined from the entire past record for that well or from a 20-year reference period, 1951–70. *Changes in ground-water levels* unless described otherwise, are from the end of October to the end of November.

The Water Resources Review is published monthly. Special-purpose and summary issues are also published. In the United States, issues of the Review are free on application to the Water Resources Review, U.S. Geological Survey, Washington, D.C. 20242.

This issue was prepared by J.C. Kammerer, H.D. Brice, E.W. Coffay, C.R. Murray, and L.C. Fleshmon from reports of the field offices, December 7, 1972.

GROUND-WATER OUTFLOW FROM CHINO BASIN, UPPER SANTA ANA VALLEY, SOUTHERN CALIFORNIA

The accompanying abstract (abridged) and map are from the report, *Ground-water outflow from Chino basin, upper Santa Ana Valley, southern California,* by J. J. French: U.S. Geological Survey Water-Supply Paper 1999-G, 28 pages, 1972; prepared in cooperation with the San Bernardino County Flood Control District. Water-Supply Paper 1999-G may be purchased for $0.25 from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

ABSTRACT

Ground-water outflow from Chino basin was calculated by a direct method using the equation $Q = PIA$, in which Q is the quantity of ground-water outflow, P is the average coefficient of permeability of the sediments through which the flow occurs, I is the average hydraulic gradient, and A is the cross-sectional area of the sediments through which the flow occurs. The period selected for the calculation was 1930–66.

Permeability of the water-bearing sediments was calculated from aquifer-test data and from computations involving specific-capacity data from 200 wells in the outflow area. Permeability ranged from less than 100 to more than 5,000 gallons per day per square foot.

The annual hydraulic gradient was derived from contour maps of average water levels in wells for each water year for the period 1930–66.

The cross-sectional area used extends southwestward from Pedley Hills to Puente Hills (fig. 1). The area of the outflow section is the saturated thickness of permeable materials measured along the line of section. Part of the lower boundary is the interface between the alluvium and the underlying basement complex, and part is a change in permeability within sedimentary rocks. Gravity and seismic traverses, drill-hole logs, and data from more than 600 drill holes, including eight test holes drilled as a part of this investigation, were used to delineate the size and the shape of the outflow area. For the period of calculation, 1930–66, the total area of the outflow section varied from about 16 to 22 million square feet due to changes in the altitude of the water table.

Annual ground-water outflow calculated by the direct method ranged from 38,000 acre-feet in the 1941 water year to 9,400 acre-feet in the 1966 water year.

Two indirect methods of calculating ground-water outflow were studied as a part of this project: the chemical method and the water-budget method. The chemical method was found to be unsatisfactory. In the water-budget method direct runoff and evapotranspiration, as determined in previous investigations, were reevaluated. Annual ground-water outflow computed by the water-budget method for the period 1933–63 ranged from 45,000 acre-feet in the 1941 water year to 10,000 acre-feet in the 1963 water year.

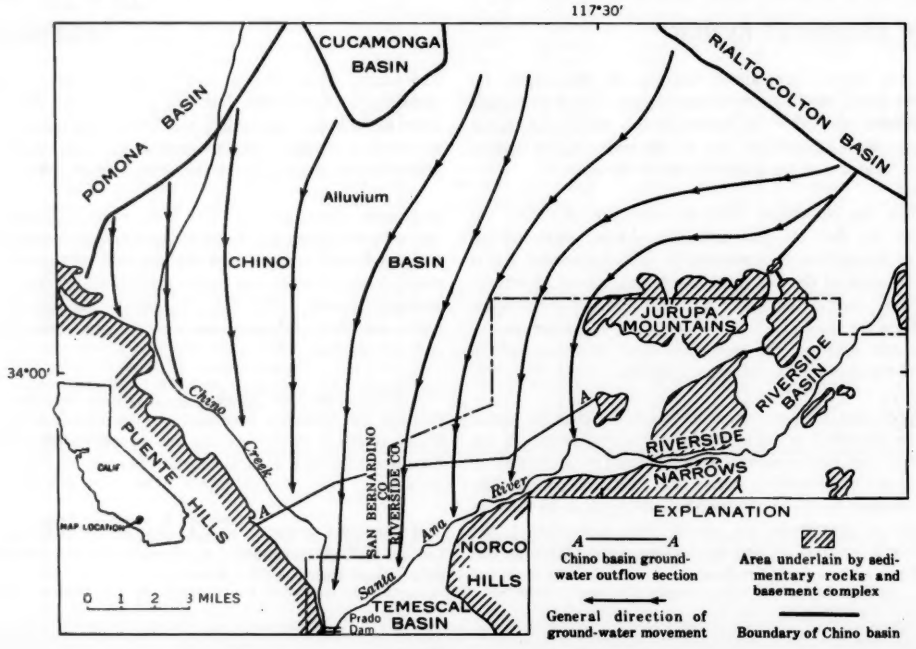


Figure 1.—General direction of ground-water movemer

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